

REVIEW ARTICLE

Evaluation Tools for Assessing Knowledge, Attitudes, and Practices Related to 3R and Waste-to-Wealth Initiatives: A Scoping Review

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ABSTRACT

Introduction: This scoping review examines current evaluation tools used to assess knowledge, attitudes, and practices (KAP) concerning 3R (Reduce, Reuse, Recycle) and waste-to-wealth initiatives. As concerns regarding waste management and sustainability globally increase, the development of effective assessment instruments is essential for understanding public behaviour and informing educational interventions. **Methods:** A systematic search was conducted across three search engines: PubMed, ProQuest, and ScienceDirect. The articles filtered were published from 2014 to 2024. Thirteen studies were selected according to specified inclusion and exclusion criteria by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. **Results:** The scoping review identified significant variability in the design, structure, and validation of KAP questionnaires. The majority of studies utilised Likert scales and binary choices. However, a standardised framework for questionnaire structure was absent across studies. Despite numerous evaluation tools being subjected to expert review and reliability testing, some did not undergo thorough validation processes. These findings are limited by inconsistencies in methodologies and the application of overly simplistic scoring systems. This can result in an inadequate representation of complex behaviours. **Conclusion:** This scoping review emphasises the necessity for a standardised KAP evaluation framework that is both methodologically rigorous and contextually appropriate. These tools are crucial for promoting public engagement in sustainable practices and informing the development of policies and programs. The findings enhance the design and implementation of future KAP assessments in environmental sustainability and waste management. *Malaysian Journal of Medicine and Health Sciences* (2026) 22(s8):342-349.doi:10.47836/mjmhs.22.s8.44

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INTRODUCTION

Globally, solid waste management remains a persistent and unresolved issue. The yearly waste generation is projected to increase by approximately 73%, from 2.0 billion tonnes in 2020 to 3.88 billion tonnes in 2050, driven primarily by rapid urbanisation, economic growth, and population expansion (1). In developing countries, ineffective waste management poses significant risks to public health and the environment, disproportionately affecting urban poor populations who are more vulnerable to pollution, infections, and waste-

related injuries due to inadequate waste collection and disposal systems (1). This particular issue arises from a collective failure of public knowledge, awareness, and also participation in waste management. In Malaysia, population growth has contributed to increasing waste generation as according to the Department of Statistics Malaysia (DOSM), the national population reached approximately 33 to 34 million by 2024, while data reported by the Solid Waste Management and Public Cleansing Corporation (SWCorp), as cited in The Star, indicate that the country generates approximately 39,000 tonnes of municipal solid waste daily, equivalent to 1.17 kg per capita per day (2, 3). Malaysia generates more waste than its neighbouring countries, including Indonesia and the Philippines, producing 0.22 kg and 0.4 kg, respectively (4). An increased disposal rate has been observed in large cities, where improvements in living standards, technological breakthroughs, and

the widespread availability of disposable products in the marketplace influence consumption habits (5). Consequently, ineffective waste management and rising disposal rates may intensify urban health risks, increase pressure on natural resources, and accelerate environmental degradation, particularly in rapidly growing cities and vulnerable populations.

One widely adopted approach to mitigating the increasing burden of solid waste is the implementation of the 3R principle (Reduce, Reuse, and Recycle), which has been promoted across many developing nations as a cornerstone of sustainable waste management and circular economy strategies (6). Although the 3R framework is conceptually well recognised, its practical adoption varies considerably across developing countries due to contextual factors such as differences in infrastructure capacity, policy enforcement, and levels of public participation. For instance, the literature suggests that some countries have made progress in integrating 3R practices, while others continue to face challenges related to inadequate recycling facilities, limited financial resources, and weak institutional coordination (6, 7). In addition, public engagement remains a critical barrier, as effective implementation of waste reduction, reuse, and recycling depends heavily on individual knowledge, attitudes, and behaviours (8). Reduce focuses on minimising waste generation at the source, reuse emphasises extending product lifespans, and recycling involves the systematic processing of waste materials; however, without sufficient public awareness and motivation, these practices are often inconsistently applied (8). Furthermore, waste-to-wealth initiatives under a circular economy framework demonstrate significant potential by reframing waste as an economic, environmental, and social resource, yet their success similarly depends on community acceptance and participation (7). These challenges highlight that technical and policy solutions alone are insufficient, underscoring the need for robust tools to assess public knowledge, attitudes, and practices (KAP) related to waste management in order to inform targeted interventions and strengthen the effectiveness of 3R and circular economy initiatives. In addition, waste-to-wealth initiatives, such as composting organic waste and converting used cooking oil into soap, exemplify effective, community-oriented solutions that convert waste into valuable products.

A sound material cycle and resource-efficient society begin with public comprehension of the 3Rs, ideally introduced at an early age (9). Recycling awareness and waste-to-wealth initiatives are essential for promoting a sustainable environment and addressing environmental issues. Hence, understanding the KAP of individuals and communities regarding waste reduction and recycling is essential for developing effective environmental education programmes and policies. KAP assessments help identify behavioural patterns, evaluate the results

of interventions, and facilitate the strategy of focused sustainability initiatives. According to Hassan and Rosli (10), KAP is a theoretical framework used for studying or examining human behaviour, focusing on specific subjects. The World Health Organisation (WHO) defines KAP as knowledge, attitude, and practice utilised for evaluating community behaviour on a subject by assessing what respondents know (K), how they respond (A), and their actions (P) (11). KAP surveys function as diagnostic tools to characterise the population's existing knowledge, attitudes, and practices, offering insights into current conditions for the design of targeted interventions. They also function as a means to assess the effectiveness of specific initiatives, interventions, or educational programmes (12). Recent methodological literature further emphasises that KAP instruments should demonstrate sound psychometric properties, including content validity, construct validity, and internal consistency, to ensure accurate measurement of behavioural constructs and contextual relevance (12,13).

Although many studies have used KAP surveys to assess the public's and society's understanding of 3R and waste-to-wealth practices, there is a lack of comprehensive synthesis regarding the tools utilised, their content, and the methodological rigour applied. This is because, without a valid framework and tools for surveys, it can affect the strategy and approaches to educate the community about the 3R and waste-to-wealth initiatives. Therefore, a thorough examination of current KAP evaluation tools is crucial to inform future research and intervention development. This scoping review aims to determine, map, and analyse the evaluation tools used in assessing knowledge, attitudes, and practices related to 3R and waste-to-wealth initiatives, with an emphasis on the methodological quality, structure, and validation status of the identified tools. Thus, the findings from this study provide opportunities for the development and standardisation of tools and questionnaires.

METHODS

Study Design

The study design employed was a scoping review guided by the methodological framework proposed by Arksey and O'Malley, with refinements by Levac et al. (14, 15). This framework comprises several key stages, including identifying the research question, identifying relevant studies, selecting studies based on predefined inclusion and exclusion criteria, charting the data, and collating, summarising, and reporting the results. Primarily, the research objectives were outlined based on the research problem, which emphasised the importance of the issue. Articles selected in the scoping review reflect the main objective of the research in analysing tools for assessing KAP related to 3R and waste-to-wealth initiatives. Besides, some inclusion and exclusion criteria were designed to ensure the scope of

the study selection is related and satisfied the research goal. Hence, the screening process was conducted to meet the relevant research criteria based on inclusion and exclusion. Lastly, the scoping review only included papers that can be retrieved for full-text access.

Search Strategy

The search strategies employed in the scoping review were crucial, as they enabled the identification of all relevant papers applicable to the research study. Papers and articles were selected from three reliable online databases that provided data and findings related to the 3R and waste-to-wealth initiatives: PubMed, ProQuest, and ScienceDirect. The search parameters were established by inserting keywords at various points that aligned with the study's aims and research questions. The database keyword search consisted of papers from 2014 to 2024 comprising the combination of the following keywords: 'Evaluation tools,' 'Assessment tools,' 'Questionnaire,' 'Knowledge, Attitude and Practice,' 'KAP Survey,' 'Behaviour Assessment,' 'Reduce, Reuse, Recycle,' '3R Practices', 'Waste Management,' 'Waste to Wealth,' 'Circular Economy.' In addition, Boolean operators were applied in the keyword search, which included AND and OR, to assist in finding specific articles and ensure that the selected studies were relevant to the study.

Study Selection: Inclusion and Exclusion Criteria

The articles' reliability for the study goal and the consistency with which data was analysed for the scoping review were heavily dependent on the inclusion and exclusion criteria. Therefore, various criteria were established and considered when choosing related papers for the scoping review. The study excluded any papers that did not meet the criteria. The inclusion and exclusion criteria are presented in **Table 1**.

Table 1: Inclusion and exclusion eligibility criteria

Inclusion Criteria	Exclusion Criteria	Justification
Published research articles were written in English.	Articles in languages other than English.	To ensure feasibility of full-text assessment and consistent interpretation of findings
Articles between the 2014 and 2024 timeframe.	Articles published before 2014.	Focus on recent developments in KAP and 3R/ waste-to-wealth initiatives
Papers related to KAP towards 3R and waste-to-wealth.	Papers not related to the study objectives.	Only studies directly relevant to the review objectives were included.
Peer-reviewed original research articles	Chapter in books, review, systematic review and discussion papers.	To ensure scientific rigor and focus on primary empirical data.
Studies retrieved through specific keyword search	Abstract or full-text unavailable.	Only studies that could be fully assessed for eligibility were included.

KAP – Knowledge, Attitudes, Practices, 3R – Reduce, Reuse, Recycle

Selection Procedures

The selection was based on Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (16). All related articles retrieved from various databases were filtered for articles published from 2014 until 2024. The following step involved the procedure of removal of duplicate articles across three databases. The next step was the selection of articles, focusing on title and abstract screening to identify any studies unrelated to the study's objectives. Then, the remaining papers were retrieved, which included all the full-text articles. After that, all the articles were thoroughly reviewed to extract information on the use of a single evaluation tool for assessing KAP towards 3R and waste-to-wealth. Articles that violated any inclusion and exclusion criteria are excluded from the study.

Data Extraction

The full-text articles that passed the screening and eligibility process were extracted using several methods, including analysis and tabulation of the articles. The final full-text articles were presented using table that included important information about the papers, such as authors, publication years, country, population, and the study's findings. Hence, the findings of this scoping review study provided tools for assessing KAP related to 3R and waste-to-wealth.

RESULTS

Journals Screened and Selected

A search across three databases (ScienceDirect, ProQuest, and PubMed) yielded a total of 3,829 articles. The removal of duplications involved 15 articles with similar titles across four databases, and the remaining 3,814 articles were further assessed for title and abstract screening. From the records screened, a total of 3,556 unrelated articles were removed. Irrelevant articles were identified through the absence of an evaluation of KAP related to 3R and waste-to-wealth in both the title and abstract. Thus, 258 remaining articles related to the study. Then, all the remaining articles were retrieved for full text to assess whether they met the requirements of the inclusion and exclusion criteria. Two hundred fourteen articles cannot be retrieved for eligibility. Only 44 articles can be assessed for eligibility, and the remaining were excluded as mentioned in the exclusion criteria. After that, 31 articles were excluded because the target population was not specified for evaluation of KAP related to 3R and waste-to-wealth. Finally, only 13 articles remained, explicitly focusing on evaluation tools related to KAP and 3R, as well as waste-to-wealth. These articles were analysed for a scoping review study. The full process including identification, screening and the key reasons for exclusion at each stage, is presented in the PRISMA 2020 flow chart (**Fig. 1**), providing transparency and justification for the reduction in included studies.

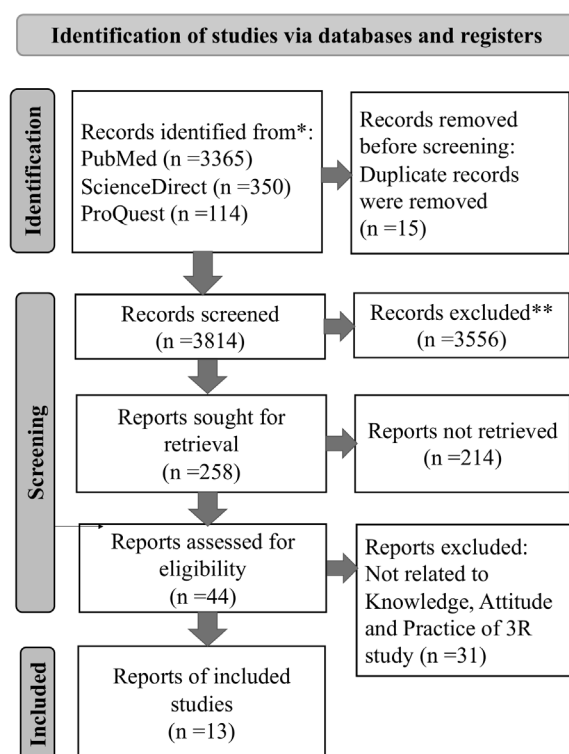


Fig. 1: Findings based on PRISMA 2020 Flow Diagramme Guidelines

All data of the main findings or results based on tools for assessing KAP related to 3R (Reduce, Reuse, and Recycle) and waste-to-wealth initiatives are gathered in **Table II**. The findings of the tools are determined based on the methodology to develop the questionnaire and structure for the KAP question.

DISCUSSION

This scoping review evaluation on KAP concerning 3R and waste-to-wealth initiatives expose significant disparities in the design, structure, and application of the evaluation tools. The diversity revealed that the studied populations differed, which led to the development of questionnaires that were not consistently standardised but occasionally adapted to fit the country and local demands.

Diversity of Evaluation Tools Across Studies

There are diverse evaluation tools in developing a questionnaire for assessing KAP related to the 3R and waste-to-wealth initiative. This heterogeneity reflects the absence of a standardised framework for KAP questionnaire development, as well as the need to adapt instruments to different cultural, educational, and contextual settings. Although no single standardised method was identified, the findings from the reviewed articles indicate several methodological approaches that demonstrate characteristics of high quality KAP questionnaires. Among the 13 selected articles, most studies employed structured questionnaires that included Likert-scale items, multiple-choice questions, and binary (yes/no) forms. For instance, Estrada-

Vidal and Tyjar-Hurtado (17) applied a five-response Likert scale to evaluate sustainability education and environmental health. Similarly, Badrum and Mapa (18) used a scoring system derived from Bloom's cut-off points to classify the respondents' level of KAP. Such scoring systems enhance interpretability by converting subjective responses into quantifiable categories. However, differences in scaling and cut-off thresholds may limit direct comparison across studies.

In addition, one study reported the use of a self-designed questionnaire aligned with the national Solid Waste and Public Cleansing Management Corporation (SWCorp) module, utilising binary scoring for correct and incorrect responses (19). While this approach offers clarity and ease of administration, particularly for large-scale or community-based surveys, it may oversimplify complex attitudes and behaviours. Additionally, the implementation of pre- and post-intervention assessments was also observed, highlighting the practical utility of KAP tools in evaluating the effectiveness of community-based programme (20). However, variation in instrument design, response scales, and timing of assessments introduces methodological inconsistency, which poses challenges to cross-study comparability and synthesis.

Although the simplified two-point Likert scale may limit data analysis, their application appears justified when aligned with the cognitive capacity and contextual needs of the target population. This is evident in Malaysian-based studies targeting citizens, secondary school students, and community groups, where questionnaire designs were tailored to local contexts. Overall, the diversity of evaluation tools underscores the balance between methodological rigor and contextual relevance, but it also highlights the need for greater standardisation to improve comparability and generalisability of KAP findings.

Questionnaire Structure in the KAP Survey

From the findings of the thirteen selected articles, there is also a variety of the questionnaire structure. None of the articles have the same questionnaire structure, although they focus on the same scope, which is 3R and the waste-to-wealth initiative. Therefore, the structure of KAP surveys shows that it exhibits various structures. Some studies have offered domains for KAP segmentation, comprising 10 questions for knowledge, 7 for attitudes, and 9 for practices (21). Hence, it ensures that the questionnaire of KAP elements is fairly constructed. In contrast, a study from Thailand on KAP of 3R focuses on more intricate aspects, such as knowledge networks and technical proficiency (22).

Findings from the questionnaire structure across the thirteen articles show that sociodemographic characteristics are consistently emphasised as a core component of KAP questionnaires. This is because

Table II: Characteristics and findings of the included studies based on assessment for knowledge, attitudes and practices related to 3R and waste-to-wealth initiatives

No	Authors and Year	Population	Sample	Country	Evaluation Tools	Questionnaire Structure
1	Abas et al., 2024	Delta Tumpat, Kelantan Community	280	Malaysia	Content validation by experts and a pilot study (Cronbach alpha value>0.7)	Section A: socio-demographic, Section B: type of waste generated per week per kg, Section C: waste disposal practices (nominal data), Section D: knowledge of waste-to-wealth programs (nominal data), Section E: awareness of waste-to-wealth programs (Five-point Likert scale), Section F: willingness to participate in waste-to-wealth programmes (Four-point Likert scale)
2	Azme et al., 2023	Communities of the Shah Alam City Council	30	Malaysia	Google Form Survey, Pre and Post Questionnaire for the community project, score and 2 Likert scale (Poor/Very Poor for the Pre and Good/Very Good for the Post)	Evaluation of the speaker's delivery, engagement effectiveness of the programme and impact of the programme
3	Badrum and Mapa, 2020	Citizens, Penampang Proper Village, Sabah	107	Malaysia	A scoring system adapted from Bloom's cut-off points was used to determine the respondents' level of KAP	Part A: Sociodemographic Information (7 questions), Part B: Knowledge (10 questions), Part C: Attitude (7 questions), Part D: Practice (9 questions)
4	Chin, Mahanta and Nath, 2023	Malaysians' citizens	294	Malaysia	Questionnaires developed based on prior experience, reviewed by 3 researchers and pretested among 10 respondents. Survey in English	33 multiple-choice questions: sociodemographic information, knowledge on plastic pollution, attitude towards plastic pollution measures and practice towards plastic use and pollution reduction.
5	Eshete, Desalegn and Tigui, 2023	Household Gelemso town	390	Ethiopia	Survey developed from different guidelines and published articles with some modifications, 4 Likert scale system for attitude, Yes or No for the knowledge and practice	Survey translated to Afan Oromo (local language), sociodemographic, households knowledge questions on solid waste management (SWM), households attitude on SWM, household practice on SWM.
6	Estrada-Vidal and Tyjar-Hurtado, 2017	College Student, University of Granada	428	Spain	Likert – type items, 5 value Environmental Health Education (EHE) and Sustainability Education (SE) scales and multiple – option items.	SE knowledge and attitude (37 items), Knowledge (yes, no, I don't know), Attitude (Likert scale from 1 to 5)
7	Hasan et al., 2024	School students	400	Bangladesh	Translated into Bangla for better understanding, review by environmental experts, seven-day pilot survey for 50 students and revised	26 items covering general information, family background and KAP assessment on 3R KAP questionnaire included 10 items assessing knowledge, 7 assessing attitude and 9 assessing practice
8	Mukama et al., 2016	Urban slums	435	Uganda	Data entered and cleaned by Epi Info 7.0 (CDC, Atlanta, USA) statistical software., Analysis by STATA 12.0 (StataCorp, Texas, USA)	English translated to Luganda (local language), social demographic, residents' waste storage, separations and disposal practices and concerns regarding poor solid waste management.
9	Phonthanukitithaworn et al. 2024	Citizens	532	Thailand	7 Likert – type items (for perception, belief and behaviours), knowledge-source item scale	5Rs external knowledge network depth, 5Rs external knowledge network breadth, 5Rs internal knowledge network source, 5Rs technical competence, 5Rs experience, and 5Rs of waste management capability output
10	Ssemugabo et al., 2020	Household, Kampala	395	Uganda	Semi structured questionnaires and observational checklist, questionnaire developed based on reviewed literature on solid waste management, data entry and analysis (EpiData version 3.02 and STATA version 14.0)	Sociodemographic, solid waste management practices at household level
11	Wang et al., 2022	Citizens, China	1200	China	Questionnaire using Jinshuju, developed by ThoughtWorks, which is an application programme that designs and sends out questionnaires, National survey spread by WeChat.	Socioeconomic characteristic, community waste services, community location, KAP of waste separation and cultural consumption in China
12	Zain et al., 2022	Primary School Students, Tumpat, Kelantan	310	Malaysia	Self-developed questionnaire which has been MYIPO copyrighted (LY2018004547) based on SWCorp (2017) module, questionnaire was validated by a group of expert panels including three lecturers specialised in this field of study, one officer from SWCorp and two primary school teachers	Part A on socio-demographic information of the students Part B is on knowledge on 3R consists of 13 questions: Score (True,1), (Wrong,0) Part C is on attitude towards 3R consists of 10 questions: Score (True,1), (Wrong,0) Part D is on practice on 3R comprised of 10 questions: This part comprised of three general questions, two questions on reduce, two questions on reuse, and three questions on recycle (Yes or No and levels determine by Bloom's cut off points)
13	Elmosaad et al. 2023	Household Al Ahsa	279	Saudi Arabia	Validity tools checked by Cronbach's alpha test (0.81), online (Google Forms)	Part 1: Variables regarding the household's socio demographic Part 2: 6 questions, general knowledge about waste management Part 3: 7 questions (4 Likert-type scale), household awareness and practice Part 4: Questions regarding type of waste, reasons not recycling waste materials.

KAP- Knowledge, Attitudes, Practices; 3R – Reduce, Reuse, Recycle; EHE - Environmental Health Education; SE - Sustainability Education; SWCorp - Solid Waste and Public Cleansing Management Corporation

sociodemographic variables such as age, occupation, income, and education play a vital role in shaping knowledge acquisition, attitude formation, and behavioural practices, as recognised in behaviour change and social ecological models. For instance, Abas et al. (23) developed their study questionnaires based on sociodemographic factors, the type of waste produced, and involvement in the waste-to-wealth initiative. This approach reflects an understanding of KAP as part of a broader social and behavioural system, where individual behaviour is influenced by personal and contextual determinants. Similarly, studies by Wang

et al. and Ssemugabo et al. highlight the importance of structuring the first section of questionnaire around sociodemographic variables (24). Although both studies adopted different methodological approaches, Wang et al. (24) used the Jinshuju application programme developed by ThoughtWorks, whereas Ssemugabo et al. (25) developed their questionnaire based on a literature review of solid waste management. These variations demonstrate that while questionnaire design methods may differ, the inclusion of sociodemographic variables remains essential for interpreting behavioural outcomes within KAP frameworks. Hence maintaining a structured

approach that integrates sociodemographic factors with knowledge, attitude, and practice domains is crucial for capturing behaviour change mechanisms and addressing gaps in KAP assessment.

Assessment of the Validation and Reliability

Validation is necessary for the KAP survey to ensure the reliability of the tools used in its development. Many studies reported conducting validation of their assessment tools using established methods. For instance, two selected studies employed expert evaluations and Cronbach's alpha to validate internal consistency ($\alpha > 0.7$) (23,26). Studies that reported such validation procedures demonstrate stronger methodological rigour and greater confidence in the interpretation of their findings.

There are also various methods of validation for the assessment tools, including expert panel review and pilot testing. For example, one study conducted expert panel evaluations with both academic and field practitioners, followed by a seven-day pilot survey among 50 students (21). Similarly, another study reported expert panel review by three researchers and pretesting with 10 respondents (27). These steps contribute to improved content validity and instrument refinement before implementation.

However, a notable limitation across the reviewed literature is that several studies did not conduct or clearly report any validation or reliability testing. For example, the study from Mukama et al. (28) failed to disclose any validation process or merely referenced pretesting with limited sample size. The absence or insufficient reporting of validation procedures represents a critical weakness in KAP tool development, as it raises concerns regarding measurement accuracy, internal consistency, and comparability of findings across studies. This highlights the need for more rigorous and transparent validation practices in future KAP research.

Strength and Limitations for the Evaluation Tools for Assessing KAP related to 3R and Waste-to-Wealth initiatives

These studies exhibit many strengths in their methodology for assessing KAP for 3R and waste-to-wealth. According to this scoping review, the majority of the participants used the verified instrument for the survey. This is because the instrument gets validation and reliability through expert panel evaluations, pilot testing, and reliability assessments employing Cronbach's alpha as a reference for validity. Additionally, this study can compile evidence from surveys conducted with different target populations. Therefore, it is easily customised for target demographics, such as secondary and primary school students, university students, and household communities. Hence, it can improve the relevance and precision of data collection.

Despite these strengths, the studies also demonstrate notable limitations. A primary concern is the lack of standardisation among studies, with evaluation tools and questionnaires differing markedly in structure and scoring methodologies. The findings suggest limited use of formal validation techniques in some cases, which may compromise the reliability and comparability of results. Another important limitation is that a substantial proportion of potentially relevant articles could not be retrieved for full-text eligibility (over 80%), which may introduce selection bias and limit the comprehensiveness of the evidence mapped. In addition, more than half of the included studies were conducted in Malaysia, reflecting a strong national research focus on 3R and waste-to-wealth initiatives but potentially limiting the generalisability of the findings to other geographical and socio-cultural contexts. Furthermore, this review focused primarily on the 3R framework and did not incorporate the broader 6R framework (Reduce, Reuse, Recycle, Recover, Redesign, Remanufacture), which is increasingly emphasised in sustainability and circular economy literature. Recognising this gap underscores the need for future research to expand evaluation tools to capture behaviours aligned with the full 6R model.

These constraints highlight an urgent need for standardised, validated, and comprehensive KAP instruments that are flexible enough to account for evolving waste management frameworks, including 6R approaches. Future studies should explore innovative evaluation methodologies that integrate both quantitative and qualitative data to improve the measurement of public knowledge, attitudes, and behaviours, thereby supporting more effective environmental education programmes, sustainability initiatives, and community engagement in the transition to a circular economy.

CONCLUSION

This scoping review systematically mapped, analysed, and compared assessment instruments used to measure KAP related to 3R and waste-to-wealth initiatives. The findings highlight the diversity and adaptability of tools across different populations and the use of validated instruments that enhance the accuracy and relevance of data collection. Importantly, the review underscores the need for standardised, flexible, and methodologically robust KAP tools that can guide policymakers, educators, and community practitioners in designing effective environmental education programs, sustainability initiatives, and waste management policies. Future research should expand to broader frameworks, such as the 6R model, and explore innovative evaluation approaches to capture complex behaviours and support community engagement. By improving KAP measurement, such studies can contribute to more effective interventions and facilitate the transition toward a circular and sustainable economy.

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